

dulums; but when it came to be tested for uniform rotation, I found the friction of the cloth washer so uncertain that the governor was of little value. Several other forms of friction under the arm A gave a like result: without any friction under A, elliptical motion was always sooner or later set up by the pin E, and at one time I almost gave up hope of overcoming the difficulty; for these experiments made it obvious that E must be free to move and yet have some *resistance to sudden change of position*, so that it could not move in an ellipse. I then devised the small train and fan-fly to meet these requirements, and the four straight rods connecting the pendulums with the rod K, instead of the rather complex parallel motion of the model. In its present form the clock seems only to require for its perfection that the spring B shall not be changed by change of temperature, and this I have no doubt can be accomplished by making it of a particular length and form.

I have purposely avoided dimensions, because these may be varied at pleasure. For instance, seconds pendulums may be used and the wheel D would then turn in two seconds; but I prefer and have used half-seconds pendulums. So the weight of the pendulums and the strength of their supporting springs may vary; but it is not desirable to have the supporting springs stronger than is necessary to carry the weight. The only dimension that perhaps ought to be given is the length of the rods H. If these are short they do not work well. Those I have in use are nine inches long, and they would work better if longer, because they would then move near the direction of the swing of the pendulum and not tend to twist it so much, as they move from side to side with the eccentric.

Sydney Observatory,
1879, March 18.

On the Applicability of the Mean Refractions of Bessel's "Fundamenta" to the Washington Observations. By A. M. W. Downing, Esq.

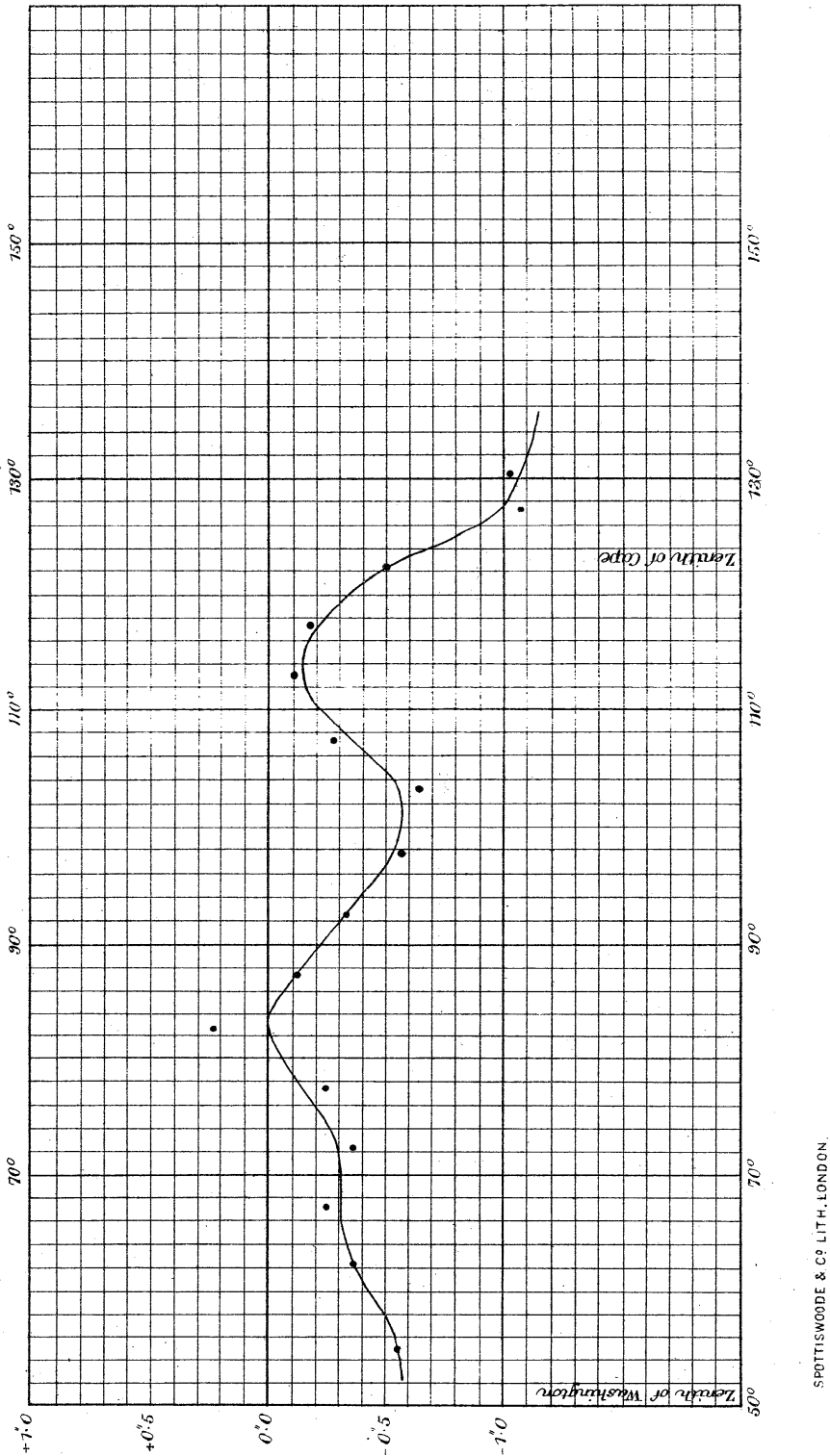
As it appears from recent investigations, the results of which are exhibited in an Addendum to the Introduction to the Greenwich Nine-Year Catalogue, that the refractions of the *Tabulæ Regiomontane* unaltered, at all events as far as 85° Z.D., represent fairly enough the Greenwich observations, I thought that it would be interesting to try whether the N.P.D.'s of the Washington Catalogue for 1860 are in satisfactory accord with observations made in the Southern Hemisphere, as these N.P.D.'s are reduced with the refractions of the *Tabulæ* unaltered. I have

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accordingly made a comparison between the N.P.D.'s of the Cape (1860) and Washington Catalogues—a work of no small magnitude, as there are just 400 stars common to the Catalogues which are available for the comparison, omitting those whose places depend on a single observation. The stars have been arranged in order of N.P.D., and the proper motions given in the Cape Catalogue applied to the Washington places; they have then been taken in groups of 5° each, and the means of the differences taken for each group. These mean differences have been laid down on cross-ruled paper, and a curve (*see diagram*) drawn through the points. The following table gives the differences as computed and as read off from the curve:—

Z.D. at Washington.	N.P.D.	Number of Stars.	Cape—Washington.	
			Means.	Curve.
° °	° '		"	"
0—9	55 24	8	—0·53	—0·53
9—14	62 32	19	—0·37	—0·37
14—19	67 45	38	—0·25	—0·30
19—24	72 13	16	—0·35	—0·30
24—29	77 33	24	—0·23	—0·16
29—34	82 31	27	+0·23	0·00
34—39	87 30	23	—0·11	—0·11
39—44	92 35	23	—0·32	—0·32
44—49	97 55	27	—0·57	—0·53
49—54	103 14	14	—0·63	—0·56
54—59	107 20	33	—0·28	—0·36
59—64	113 4	22	—0·10	—0·16
64—69	117 26	59	—0·18	—0·22
69—74	122 10	40	—0·50	—0·50
74—78	127 2	14	—1·09	—0·97
78—82	130 23	8	—1·03	—1·07
82—85	134 10	2	—3·50	—
85—87	136 49	2	—3·85	—

In order to assure myself of the reality of the discordances in the last three groups, I have computed the differences of the Washington and Melbourne (1870) places south of N.P.D. 129° , the Melbourne places being reduced to the Cape standard by the table given on page 176 of the present volume of the *Monthly Notices*. The following is the result:—



N.P.D. °		Number of Stars.	Melbourne—Washington. "
130	16	16	-1'32
134	25	3	-3'62
136	49	2	-3'96

The difference at Z.D. 82° — 85° is untrustworthy, as one of the stars employed, occurring in both the Cape and Melbourne comparisons, is very discordant; if this star, whose place in the Washington Catalogue depends on only two observations, be rejected, the mean of the comparisons with the places in the Southern Catalogues is $-1''\cdot55$. I propose to adopt this as the difference for N.P.D. $134^{\circ} 21'$.

The readings from the curve for every 5° (with computed values below 80° Z.D.) then give—

Z.D. °		N.P.D. °		Cape—Washington. "
4		55		-0'55
9		60		-0'43
14		65		-0'33
19		70		-0'31
24		75		-0'25
29		80		-0'07
34		85		-0'05
39		90		-0'22
44		95		-0'44
49		100		-0'56
54		105		-0'50
59		110		-0'23
64		115		-0'17
69		120		-0'36
74		125		-0'80
79		130		-1'07
83	15	134	21	-1'55
85	43	136	49	-3'85

It is evident that, in addition to discordances arising from other causes than refraction, the tabular refractions used at Washington must be diminished in order that the observations may agree with those made at the Cape. Now, as far as 85° Z.D. the mean refractions of the *Fundamenta* are those of the *Tabulæ* diminished in the proportion of $1:0\cdot996718$, and a preliminary calculation showed that this was very nearly the proportion in which the Washington refractions should be diminished. By substituting the mean refractions of the *Fundamenta* for those of the *Tabulæ*, the discordances are reduced as follows:—

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Z.D.			Z.D.		
°	"		°	"	
4	−0°55	to −0°54	49	−0°56	to −0°34
9	−0°43	−0°40	54	−0°50	−0°24
14	−0°33	−0°28	59	−0°23	+0°07
19	−0°31	−0°24	64	−0°17	+0°23
24	−0°25	−0°17	69	−0°36	+0°13
29	−0°07	+0°03	74	−0°80	−0°13
34	−0°05	+0°07	79	−1°07	−0°15
39	−0°22	−0°07	83½	−1°55	+0°01
44	−0°44	−0°26	85¾	−3°85	−0°62

If then the Washington observations were reduced with the mean refractions of the *Fundamenta* and the meteorological corrections of the *Tabulæ*, the agreement with the Cape observations would be very satisfactory if we may assume that the relative correction for errors of the adopted latitudes is small.

It appears from this investigation, and also from the comparison of the Cape and Greenwich Catalogues referred to above, that the tabular refractions used in the reduction of the Cape observations also require to be somewhat diminished.

1879, June 10.

Ephemeris for Physical Observations of Mars, 1879–80. By A. Marth, Esq.

Greenwich Noon.	Angle of Posit. of J's Axis.	Areographical W. Long. of the Centre of J's Disk.	Lat. Diff.	Dia-meter.	Amount and Posit. of Greatest Defect of Illumination.	Areocentric Ang. between Earth & Sun.
1879.	°	°	°	"	"	°
July 29	143°34	299°53	700°63	10°38	1°66	250°39
31	143°19	280°16	64	10°51	1°67	250°68
Aug. 2	143°06	260°80	66	10°64	1°69	250°98
4	142°95	241°46	68	10°78	1°70	251°28
6	142°85	222°14	71	10°92	1°72	251°58
8	142°77	202°85	73	11°06	1°73	251°89
10	142°71	183°58	75	11°21	1°74	252°20
12	142°66	164°33	78	11°36	1°75	252°52
14	142°62	145°11	79	11°51	1°76	252°84
16	142°60	125°90	82	11°67	1°77	253°15
18	142°59	106°72	85	11°83	1°77	253°47